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(54) OPTICAL DISK AND OPTICAL RECORDING/REPRODUCING METHOD

(57)Abstract:

PROBLEM TO BE SOLVED: To suppress variance in recording/reproducing conditions or tracking conditions in a multilayer optical disk in which a plurality of information layers are laminated.

SOLUTION: In the optical disk in which at least two information layers are laminated, when the inner circumferential radius of an information area in the information layer of k-th from the incident side of a laser light for recording and/or reproducing is I_k , an outer circumferential radius E_k , the inner circumferential radius of an information area in the information layer of $k+1$ -th is I_{k+1} , an outer circumferential radius E_{k+1} , a distance between the information layer of k -th and the information layer of $k+1$ -th is d_k , and an effective numerical aperture of the laser light in the optical disk of an irradiation optical system is NA , the followings are established: $I_{k+1}-I_k \leq d_k \cdot NA / (1-NA^2) \cdot 1/2$, $E_k-E_{k+1} \leq d_k \cdot NA / (1-NA^2) \cdot 1/2$.

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CLAIMS

[Claim(s)]

[Claim 1]Are the optical disc in which at least two information layers were laminated, count from a side into which a laser beam for record and/or playback enters, and an inner circumference radius of an information area in the k-th information layer I_k , Make a peripheral radius into E_k and an inner circumference radius of an information area in the k+1st information layers I_{k+1} , When a peripheral radius is made into E_{k+1} , distance of the k-th information layer and the k+1st information layers is made into d_k and an effectual numerical aperture in an optical disc of an irradiation optical system of said laser beam is set to NA, An optical disc which are $I_{k+1}-I_k \geq d_k$ and $NA/(1-NA^2)^{1/2}$ and $E_k-E_{k+1} \geq d_k$ and $NA/(1-NA^2)^{1/2}$.

[Claim 2]An optical disc of claim 1 in which at least one layer of said information layer is an optical recording layer in which optical recording is possible, and an information layer of at least one layer exists in the laser beam incidence side of this optical recording layer.

[Claim 3]It is the method of performing record and/or playback by irradiating with a laser beam to an optical disc in which at least two information layers were laminated, It faces setting up an information area which counts from the incidence side of said laser beam, and is the target of record and/or reproduction to the k+1st information layers, Count from the incidence side of said laser beam, and an inner circumference radius of an information area in the k-th information layer I_k , Make a peripheral radius into E_k and an inner circumference radius of an information area in the k+1st information layers I_{k+1} , When a peripheral radius is made into E_{k+1} , distance of the k-th information layer and the k+1st information layers is made into d_k and an effectual numerical aperture in an optical disc of an irradiation optical system of said laser beam is set to NA, An optical recording regeneration method made into $I_{k+1}-I_k \geq d_k$ and $NA/(1-NA^2)^{1/2}$ and $E_k-E_{k+1} \geq d_k$ and $NA/(1-NA^2)^{1/2}$.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Field of the Invention]This invention relates to optical discs, such as an only for [playback] type optical disc, and an optical recording disk, and the method of performing record reproduction to this optical disc.

[0002]

[Description of the Prior Art]In recent years, the demand of densification and large-scale-izing to an optical disc is remarkable. Although DVD (Digital Versatile Disk) with the storage capacity of about 4.7 GB of one side corresponding by about 7 times the compact disk is released now, development of the art which can record more information is performed briskly.

[0003]As art which raises the storage capacity of an optical disc, the short wavelength formation of record reproduction light, a raise in NA (numerical aperture) of the object lens in a record reproduction Mitsuteru light reflection study system, multilayering of an information layer, multiple-value record, etc. are mentioned. Compared with short wavelength formation or a raise in NA, fast high-capacity-izing is [among these] possible for the three-dimensional record by multilayering of information layers, such as a recording layer and a layer only for reproduction, at low cost. Three-dimensional information media are indicated, for example to the patent No. 2997512 gazette and JP,9-44898,A.

[0004]

[Problem(s) to be Solved by the Invention]When reproducing the multilayer recording medium which multilayered information layers, such as a recording layer and a layer only for reproduction, the catoptric light from information layers other than a reproduction object, i.e., information layers other than the information layer in which regenerated light is focusing, will also return to the optical pickup which irradiates with regenerated light. Therefore, signal interference arises among two or more information layers, and this serves as a cross talk. As a result, it is easy to mix a noise in a regenerative signal. The influence of the catoptric light which returns from information layers other than a reproduction object becomes small in inverse proportion to the square of the distance between information layers. Therefore, it is so desirable that the distance between information layers is large in order to suppress mixing of a noise.

[0005]However, when distance between information layers is enlarged, in order to prevent a disk becoming thick too much, the number of laminations of an information layer will be restricted, therefore the storage capacity of an entire disk will also be restricted. In the high numerical aperture system using 2 group lens, since the working distance between a lens and a medium becomes small, it is necessary to make distance between information layers small.

[0006]Therefore, it is important to reduce a cross talk when distance between information layers is shortened in a multilayered information medium, especially the multilayered information medium for which a high numerical aperture system is used. In a multilayered information medium, when the laser beam for record reproduction is irradiated through other information layers, the laser beam which reaches the information layer for record reproduction will decline in response to the influence of the transmissivity of an information layer besides the above. A problem is not so large if this attenuation is uniform. However, uneven patterns, such as prepit and a groove, exist in the information area of an information layer. On the other hand, since focusing of the laser beam is carried out so that it may focus to the information layer for record reproduction, it serves as a spot which spread remarkably in the position of the information layer which exists to the front from it. Therefore, in the information layer for record reproduction, when carrying out record reproduction near an internal circumference edge and near a periphery edge an information area, the boundary of an uneven pattern and the other flat part will exist in the laser beam spot which spread in the information layer of a near side from it. Since laser beams are scattered about with the above-mentioned uneven pattern, an uneven pattern will differ in transmissivity from a flat part. Therefore, the intensity of the laser beam which reaches the information layer for record reproduction will be changed, and, as a result, the record reproduction and tracking in an optimal condition will become impossible. Especially the adverse effect by such transmissivity change poses a problem in the case of record, and influence becomes large especially in the system which records by low power.

[0007]In the multilayered optical disk which laminated two or more information layers, an object of this invention is to suppress change of record reproduction conditions or tracking conditions.

[0008]

[Means for Solving the Problem]Such a purpose is attained by this invention of following the (1) – (3).

(1) It is the optical disc in which at least two information layers were laminated, Count from a side into which a laser beam for record and/or reproduction enters, and an inner circumference radius of an information area in the k-th information layer I_k , Make a peripheral radius into E_k and an inner circumference radius of an information area in the k+1st information layers I_{k+1} , When a peripheral radius is made into E_{k+1} , distance of the k-th information layer and the k+1st information layers is made into d_k and an effectual numerical aperture in an optical disc of an irradiation optical system of said laser beam is set to NA, An optical disc which are $I_{k+1}-I_k \geq d_k$ and $NA/(1-NA^2)^{1/2}$ and $E_k-E_{k+1} \geq d_k$ and $NA/(1-NA^2)^{1/2}$.

(2) An optical disc of the above (1) in which at least one layer of said information layer is an optical recording layer in which optical recording is possible, and an information layer of at least one layer exists in the laser beam incidence side of this optical recording layer.

(3) It is the method of performing record and/or playback by irradiating with a laser beam to an optical disc in which at least two information layers were laminated, It faces setting up an information area which counts from the incidence side of said laser beam, and is the target of record and/or reproduction to the k+1st information layers, Count from the incidence side of said laser beam, and an inner circumference radius of an information area in the k-th information layer I_k , Make a peripheral radius into E_k and an inner circumference radius of an information area in the k+1st information layers I_{k+1} , When a peripheral radius is made into E_{k+1} , distance of the k-th information layer and the k+1st information layers is made into d_k and an effectual numerical aperture in an optical disc of an irradiation optical system of said laser beam is set to NA, An optical recording regeneration method made into $I_{k+1}-I_k \geq d_k$ and $NA/(1-NA^2)^{1/2}$ and $E_k-E_{k+1} \geq d_k$ and $NA/(1-NA^2)^{1/2}$.

[0009]

[Embodiment of the Invention]The example of composition of the multilayered optical disk in which two or more information layers were laminated is shown in drawing 1 and drawing 2, respectively. The laser beam for record and/or reproduction enters from the method of figure Nakagami. It counts in drawing 1 and drawing 2 from the laser beam incidence side, and information area A_{k+1} of information area A_k of the k-th information layer and the k+1st information layers is displayed on them. The distance between these information areas is d_k .

[0010]The laser beam which focuses to information area A_{k+1} serves as a spot which spread greatly on information area A_k and the diameter ϕ_{i_k} is geometrically expressed with $\phi_{i_k}=2d_k$ and $NA/(1-NA^2)^{1/2}$. NA is a numerical aperture of the object lens of the irradiation optical system of a laser beam. However, within an optical disc, since the medium of a laser beam is not air, NA in this specification is taken as the effectual numerical aperture according to the optical disc component near an information layer.

[0011]Drawing 2 shows the conventional optical disc. In information area A_k of this optical disc, and information area A_{k+1} , each inner circumference radius is I and each peripheral radius is E. Therefore, while the laser beam is focusing in a lower information layer to the periphery edge or internal circumference edge of information area A_{k+1} , in an upper information layer, laser beam spot is protruded from information area A_k by the radius ($\phi_{i_k}/2$).

Therefore, as mentioned above, in lower information area A_{k+1} , record reproduction conditions will differ from tracking conditions in the time of carrying out record reproduction near a center, and the time of carrying out record reproduction near a periphery edge or near an internal circumference edge.

[0012]On the other hand, as shown [this invention] in drawing 1, when it is considered as $**I_k=I_{k+1}-I_k$ and $**E_k=E_k-E_{k+1}$, It is considered as $**I_k \geq \phi_{i_k}/2=d_k$ and $NA/(1-NA^2)^{1/2}$, and $**E_k \geq \phi_{i_k}/2=d_k$ and $NA/(1-NA^2)^{1/2}$, and is preferably referred to as $**I_k \geq \phi_{i_k}/2$, and $**E_k \geq \phi_{i_k}/2$. That is, while the laser beam is focusing to lower information area A_{k+1} , the inside diameter of information area A_k is made small, and an outer diameter is enlarged so that laser beam spot may not overflow upper information area A_k . Thereby, in lower information area A_{k+1} , changing record reproduction conditions and tracking conditions is lost in the time of carrying out record reproduction near a center, and the time of carrying out record reproduction near a periphery edge or near an internal circumference edge.

[0013]The information layer in this specification includes the layer only for reproduction, or an optical recording layer. The layer only for reproduction is usually a metal layer, a semimetal layer, a dielectric multilayer, etc. in which prepit was provided in part at least. On the other hand, an optical recording layer is a phase change type recording layer, a magneto-optical recording layer, an organic-coloring-matter content recording layer, etc. in which the groove (guide rail) and land for tracking servos were provided by turns at least in part. The field which prepit and a groove are provided among these information layers, and serves as a record reproduction object is an information area.

[0014]However, for example in the information layer of the drawing 1 bottom, the groove formation area and the prepit formation area may spread out exceeding information area A_{k+1} . It is necessary to set neither all the groove formation areas nor prepit formation areas as the record reproduction object, and what is necessary is just to set up the part of them as a record reproduction field according to this invention. For example, in all the information

layers, the inner circumference radius and peripheral radius of a groove formation area or a prepit formation area may be made the same, and only the size of an information area may be set up according to this invention in each information layer.

[0015]

[Example]A reflecting layer, a dielectric layer, the 2nd phase change type recording layer, and a dielectric layer were laminated on the with a [120 mm in diameter and 1.2 mm in thickness] which have example 1 groove and a land support base made from polycarbonate. After initializing the 2nd recording layer (crystallization), it consisted of ultraviolet curing type resin, and the interlayer who has a groove and a land was formed by the 2P method. Subsequently, a dielectric layer, the 1st phase change type recording layer, and a dielectric layer were formed on the interlayer. After initializing the 1st recording layer, the protective layer which consists of ultraviolet curing type resin was formed, and it was considered as the optical recording disk sample.

[0016]The record track pitch in the land groove-recordings method of this sample could be 0.3 micrometer. The groove formation area (information area A_1) of the 1st recording layer was set to inner circumference radius $I_1:20.0\text{mm}$ and peripheral-radius $E_1:58.0\text{mm}$. The groove formation area (information area A_2) of the 2nd recording layer was set to inner circumference radius $I_2:20.1\text{mm}$ and peripheral-radius $E_2:57.9\text{mm}$. That is, it could be $**I_1=**E_1=100\text{micrometer}$. Distance d_1 of the 1st recording layer and the 2nd recording layer could be 20 micrometers.

[0017]The recording reproduction characteristics and the tracking characteristic of the above-mentioned sample were evaluated using the optical disc evaluation system which has an optical pickup of the laser wavelength of 405 nm, and the numerical aperture 0.85. After having recorded from the most inner track of the 1st recording layer to the outermost periphery track, ranking second and carrying out a focusing jump to the 2nd recording layer layer first on the occasion of this evaluation, operation recorded from the outermost periphery track of the 2nd recording layer to the most inner track was performed. As a result, also in any of the 1st recording layer and the 2nd recording layer, tracking and record were possible in the whole region.

[0018]The refractive index in the wavelength of 405 nm of the ultraviolet curing type resin which constitutes an interlayer and a protective layer is 1.56, and on the other hand, since a dielectric layer and a recording layer are very thin compared with an interlayer and a protective layer, the effectual numerical aperture NA in a sample is set to $0.85/1.56=0.545$. Therefore, it is $\phi_1/2=d_1$ and $NA/(1-NA^2)^{1/2}=13\text{micrometer}$, and $**I_1>\phi_1/2$, and $**E_1>\phi_1/2$ are materialized.

[0019]It was referred to as comparative example 1 inner-circumference radius $I_2:20.0\text{mm}$ and peripheral-radius $E_2:58.0\text{mm}$, and also was referred to as $**I_1=**E_1=0\text{micrometer}$, and also the optical recording disk sample was produced like Example 1.

[0020]When recording operation is started to the 2nd recording layer, tracking operation becomes unstable and it is impossible to record, after carrying out a focusing jump to the 2nd recording layer from the 1st recording layer, when the evaluation same about this sample as Example 1 is performed.

[0021]

[Effect of the Invention]In this invention, in the multilayered optical disk in which two or more information layers were laminated, since the inside diameter and outer diameter of an information area are controlled according to the lamination station of an information layer, recording reproduction characteristics and a tracking characteristic stable in the whole region of an information area are acquired.

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